Indications for thermography in the United States

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SUMMARY. The currently accepted indications for thermography in the United States are reviewed. Breast cancer detection remains the most common indication for telethermography, and evidence has been presented to suggest that thermography is an excellent risk indicator. Thermography is also widely used for evaluation of peripheral vascular diseases, diagnosis of deep venous thrombosis, and in identification of patients wbo are stroke-prone. Scrotal tbermograpby is becoming an important diagnostic tool, both for identification of subclinical varicoceles and in screening for testicular cancer. Additional uses in the study of cronic pain, insensitive limbs, trauma, burns, and reconstructive surgery are also discussed.

Key words: telethermography indications review United States.

Medical thermography has come a long way since it was introduced in Canada by Lawson and in the United States by Gershon-Cohen and his associates. For many years, nearly all thermographic studies were limited to the evaluation of the breasts, and most thermographers used the Barnes instrument. More recently, various new indications have been proposed and successfully tested; and modem equipment, such as (in alphabetic order) the AGA Thermovision, Bofors, Spectotherm, and Thermiscope have become available and widely put to clinical use. In contrast with some European countries, only telethermography has taken a strong foothold in the United States, although some centers do experiment with contact and plate thermography.

Since most of this paper will deal with breast thermography, recognized indications in fields other than mammary studies will be first discussed.

Peripheral vascular disease of all types seems to have formed one of the largest groups of indications for telethermography. Numerous clinicians and investigators feel that all patients with pain in the extremities or subjective temperature changes should have thermography, which can be of great help in diagnosing peripheral vascular insufficiency due to arteriosclerosis, collagen diseases, Raynaud's phenomenon, and other causes. While many of the changes are nonspecific, some conditions, such as the occlusion of the femoral artery, cause thermographically-detectable typical collateral circulation around the knee. There is also increasing use of thermography in the postoperative follow-up of patients who have had vascular grafts, since it is a simple, painless technique which can be repeated with any frequency. Pharmacologically, thermography has been used to test the vasomotor effects of drugs.

Thermography of the extremities is also used to objectively document the course of different types of arthritis and their response to treatment. This application is still new and further studies are needed to assess its value.

The diagnosis of deep venous thrombosis and the follow-up of patients under treatment for this condition appear to be another major indication for thermography. Lapayowker believes that thermography may be even more sensitive and more revealing than venography in this condition. The diagnosis of calf pain remains often a frustrating problem, especially in postoperative patients, but also in young women who are pregnant or who are taking oral contraceptives. Thermographic scre-

ening of these patients brings simple, noninvasive information, which is being widely accepted.

Screening of patients who are stroke-prone because of arteriosclerosis or hypertension is another widely used indication for thermography. Unilateral periocular or supraorbital cooling, particularly after compression of the temporal arteries, is a sign of internal carotid insufficiency and should be further confirmed by angiography. This indication is particularly important, since surgical stroke prevention by means of carotid endarterectomy is possible. Neurosurgeons also feel that thermography provides an ideal follow-up technique in postoperative patients, since it is noninvasive and may be repeated as often as desired.

Thermography can also help in the evaluation of patients with chronic pain. Uematsu of Johns Hopkins University feels that thermography is a useful test of sympathetic function, superior to any other methods which have been used clinically. Specifically, thermography may help to identify patients with causalgia and 'reflex sympathetic dystrophy, and patients with positive findings can be successfully treated and followed with sympathetic blocks or sympathectomies.

The use of scrotal thermography for varicocele has also become widespread during the past year. A great deal of credit for this should go to Comhaire et al. of Belgium, whose studies were widely read in our country and whose good results are being confirmed in different centers. This role of thermography is unique, since there is no other noninvasive method for the objective documentation of varicocele. Scrotal thermography is also used with increasing frequency to screen for testicular carcinoma in men with testicular pain but no palpable mass.

Thermography has also been applied in the investigation of athletic or work injuries of the knee and of the back, in screening for melanoma, in the evaluation of thyroid and parathyroid tumours, and in the localization of the placenta. All of these appear to be valid indications, but the comparative value of thermography with other tests is still unsettled.

There seems to be enthusiasm for the use of thermography in the evaluation of insensitive limbs and the subsequent prevention of gangrene. It has been reported that thermographic changes may precede clinical signs by several years in cases of neuropathic arthropathy. Brand's work using thermography in the management of insensitive limbs of patients with leprosy has led to further exploration. Investigators have also begun to use thermography in reconstructive and rehabilitative surgery and follow-up. A very new study, and one that is yet to be published, is that of thermographic scans of burned patients. It is thought that in those severely burned, who cannot be easily moved or even handled, thermographic scans may be able to display healing or infection inhibiting the healing process.

Of all thermographic techniques, breast thermography has received and continues to receive the most widespread attention in the United States. After the initial work of Lawson and of Gershon-Cohen and his co-workers, it was hoped that a breast thermogram interpreted as << positive >> would indicate the presence of cancer and as « negative », the absence of cancer. Basically, two events shook faith and deflated enthusiasm in breast thermography: first, the realization that there are a significant number of false positive and false negative thermograms, and secondly, the fact that because of National Cancer Institute - American Cancer Society grants, large groups of radiologists were pressured to use breast thermography, in addition to mammography, without prior training and sometimes without the correct equipment. To compound the problem, no guidelines existed to classify a thermogram as positive or negative, and many of the interpretational criteria were ambiguous and open ended. The Breast Cancer Detection Projects created by these grants, however, achieved excellent results and detected an average of 10.5 cancers per 1000 women screened, although nearly all detections were due to mammography, which had a 92% true positive rate. Thermography was positive in only 39% of cancers among those initially screened and falsely negative in 69%. While the national project director clearly stated that these poor thermographic results were most likely due to lack of expertise and inadequate instrumentation, a widespread negative attitude began to prevail toward breast thermography. Essentially, it was understood that, while mammography was an accurate detection and diagnostic method, thermography was inaccurate.

Consequently, the very use of this technique was questioned.

Following a very pessimistic 1975, the tide turned in 1976, when physicians and scientists openly debated the possibility that routine, periodic mammography, started at a young age, may cause breast cancer and may actually cause more deaths than saving lives by providing early diagnosis.

While this debate continues, the realization that mammography alone is not adequate in breast cancer screening gives a new impetus to thermography. Clinicians, especially gynecologists, have begun to do breast thermography as part of the routine preventive gynecologic examination and have found that thermography, combined with total clinical evaluation and selective mammography, picks up most cases of breast cancer early. Further evidence has accumulated to suggest that thermograms taken annually on each patient will single out those who should have repeat mammograms.

A national data pool was formed by gynecologists who use thermography. Using the TH class system developed by Amalric and Spitalier, it is projected that so far about 65% of unselected patients are classified THl-TH2, 22% as TH3, and 13% as TH4 or TH5. While the preliminary data suggest that only 10% of the cancers are THl-TH2 (Table I), it is anticipated that as the numbers increase more T_1N_0 tumors will be found in high risk patients with negative thermograms and positive mammograms. It is currently recommended that each thermographic evaluation be correlated with history and physical examination and that women over 35 have an initial mammogram. For follow-up exams, patients with TH3, TH4, and TH5 thermograms and those at high risk for other reasons are followed by annual mammograms, whereas those with THl-TH2 thermograms are followed with

Tab. I. **Thermography data pool initial results of cancer screening with palpation, thermography, and selective mammography.**

Population: unselected gynecologic patients; *No lower age limit,* estimated 35% of patients *under 35 years of age.*	
Initial examinations	10,604
Follow-up examinations	3,049
Breast cancer prevalence	55 (0.52%)
Breast cancer incidence	8 (0.26%)
No node involvement	40/55 (73%)
Thermograms false negative	5/55 (9.1%)
Mammograms false negative	12/55 (21.8%)

Tab. II. **Categories of breast thermograms (American Thermographic Society).**

A. NORMAL

B. ASYMMETRIC - Minimal (suspicious thermogram). Not clearly normal of abnormal. This category should include and be reported if any one of the following:

I. Graphic Criteria
   a. Unilateral or asymmetric vascularity with vessels of normal caliber and temperature.
   b. Localized rigidity (edge sign).

II. Thermal Criteria
   a. Unilateral increase in vessel temperature of approximately 2°C or less without increase in vessel number or caliber.
   b. Localized (focal) area of increased nonvascular surface temperature of approximately 2 ° or less, including the areolar area.

Any two of the above criteria found in one breast should be considered as a clearly abnormal breast thermogram.

C. ABNORMAL THERMOGRAM

I. Graphic Criteria
   a. *Marked* unilateral increase in vascularity (number), caliber or configuration of vessels.

II. Thermal Criteria
   a. Focal increase of approximately 3 º or more, including the areolar area.
   b. Diffuse *global* hyperthermia.
   c. Diffuse regional or quadrant hyperthermia.

clinical and thermographic examinations, with mammography added only whenever a change is noted in either the clinical or thermographic findings.

It has been shown in two independent studies that thermograms are excellent risk indicators. Hobbins found that while the overall breast cancer incidence is 1 in 400, the risk with a normal thermogram is 1 in 2824, 1 in 299 with a suspicious thermogram, and 1 in 68 with a positive thermogram. Nyirjesy et al. demonstrated that the risk of cancer is 0.1% in classes THl-TH2, 0.82% in class TH3, 3.17% in class TH4, and 37.5% in TH5.

While there is still no uniform view on breast thermography in the United States, it is now widely recognized that good results can be achieved only if there is good quality control for technique and interpretation. Guidelines for both of these were issued by the American Thermographic Society in 1976 (Table II), and there is hope that these recommendations will be widely implemented. At this time, there seems to be a certain dichotomy between the interpretational methods of gynecologists, most of whom use the quantitative criteria defined by Amalric and Spitalier, and those of radiologists, who rely on the quaiitative differences produced by venous patterns and background heat and who do not measure temperature differences.

In summary, thermography has continued to expand in the United States. Its attraction is that it is rapid and noninvasive. Since thermographic data are usually nonspecific for any one disease, the technique seems to be better accepted by clinicians, who can directly correlate thermic information with the overall evaluation of the patient, than by physicians involved in mass screening, where thermograms are read in isolation from other methods. As with all new techniques, controversies remain, but these should stimulate progress.